PEST TECHNOLOGY
Pest Control and Pesticides

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Research and Education

AT LAST July is over, now, after the mad-cap merry-go-round we can pause for a while to restore our tangled, jangled nerves and try to place in proper perspective the events which have occured during this last hectic month. In this case it is an even more difficult task for, sad to say, I am writing this leader whilst on holiday. Believe me the surrounding temptations of sunshine, sand and sea do not create conducive conditions for serious thought. However even in such circumstances one or two reflections come to mind.

Throughout the entire proceedings of the 7th Commonwealth Entomological Conference one main theme was common to all speakers. This theme was, of course, the plea for more research in order to obtain the best results from pest control operations and in order to prevent unwanted side effects on beneficial insects, animals and man. In particular it was emphasised that there was a need for greater study of pest ecology, especially its behaviour and relationship with other insects such as its parasites and predators. There was also a call for more co-operation between research workers in the various branches of chemistry, physics, botany, agriculture and zoology which influence the adoption of pest control methods. During the conference several speakers gave examples to show how research and co-operation between research workers had enabled the cost of pest control operations to be reduced to a considerable extent.

It must be remembered that this appeal for more research is not new; it has been made many times before and it is also one of our own 'battle cries'. No doubt scientists will continue to make this appeal for ever. The main problem is to persuade the government or some sufficiently wealthy private organisation to provide the necessary funds.

Research can be a costly business, and the results of any one project cannot be guaranteed. Moreover, except on rare occasions, obvious economic benefit only occures as a result of pooling bits and pieces of knowledge accumulated from numerous research projects. Whoever provides the money, then, must be farsighted enough to take the long term view and realise that the benefits, that will eventually accrue may not show themselves in pounds, shillings and pence.

It is evident from the fact that pest control and science as a whole has, and is progressing, that there are organisations who are prepared to take this view but it is also evident that others have yet to be convinced. Perhaps in addition to research workers we also need "missionaries", "diplomats", "education-alists"—call them them what you will—to persuade governments that taking the long term view will pay in the end.

Talking of research, the progress it brings, and "educators" reminds us of yet another problem, that of keeping the public informed of the progress that has been made. In a recent speech at Gatlingburg, Tennessee, Denis Hayley, Director of Information for the National Agricultural Chemicals Association (of America) stated that this day and age was essentially one of rapid change and added:—

"The growing pace of to-days' progress puts a severe strain on many people Adjustments to new conditions and new beliefs about the world around us are always painful. Our grandfathers had a lifetime to adjust to a major change. We must learn to adjust to major changes at the faster rate of three or more per life time.

"Old and familiar beliefs die slowly with many people and it is not surprising that many fall behind the times today. Nor is it surprising that some, with eyes focussed upon narrow fields of interest, want to slow down or even reverse the march of progress.

"The challenging or shattering of an old belief for some, is like an earthquake to others. Their reaction is immediate and unreasoned fear and therefore just as our modern age is one of rapid change it is also an age of fear."

This fear is, of course the fear of what may happen, the fear of the unknown. Unless the public is kept informed and reassured of the progress made with regard to the production of agricultural chemicals which are safer towards man, his lifestock and wild life, they will be afraid of them.

It is up to the industry to keep the public abreast of new developments so that they will not, through lack of knowledge, fearfully associate the present day use of pesticides with those ailments, such as cancer, that at present are the major natural causes of death.

Notes on the 7th Commonwealth Entomological Conference

THE 7th Commonwealth Entomological Conference lasted for 10 days, during which time some 31 speakers, all acknowledged experts in their own field, gave papers at the open meetings. Many others, including experts and laymen entered into discussions on the papers. This all adds up to an awful lot of words, facts, figures and general information.

As we do not have enough space to give a comprehensive account of each paper there will undoubtedly be some gaps in this report, the function of which is to draw attention to a few of the many points of interest likely to be of interest to our readers. Anyone wishing more detailed information may find it in the "Proceedings of the 7th Commonwealth Entomological Conference" which will be published in due course.

Recent Developments in Insecticides for Crop Protection

The conference got off to an excellent start with a paper on "Recent developments in insecticides for crop protection" given by Dr. J. T. Martin, who discussed the merits and uses of many of the chemicals which have recently been introduced on to the market or which are at present undergoing extensive trials. Dr. Martin welcomed the present trend particularly amongst the organophosphorous compounds towards the development of more specific, less toxic (towards man, livestock and wild life especially beneficial insects) chemicals. Illustrating this trend Dr. Martin pointed out that some of the recently introduced compounds such as Co-Ral and Etrolene were safe enough to be used for the systemic control of cattle grubs; other chemicals such as dimethoate (Rogor) were used for the systemic control of plant pests such as aphids, thrips, etc., and once the initial application had been absorbed by the plant there was little or no hazard to beneficial insects. The triazinyl organophosphorous compounds, which are rapidly absorbed by plants and have little or no effect on insects other than aphids, was noted as a recent development of great promise. The newer chlorinated hydrocarbon insecticides unfortunately appeared to be more toxic towards mammals and beneficial insects.

The residual insecticides present individual problems, Tedion for example is a very specific contact acaricide and presents little hazard to man and beneficial insects.

The mammalian toxicity of Thiodan, a contact and stomach poison, has not been determined satisfactorily, and fluctuates with different reports. Sevin, a contact carbamate insecticide whose main asset appears to be its effectiveness against pests which are difficult to control by other chemicals, has a long residual effect which may present a hazard to pest predators and other insects.

Dr. Martin's concern for wild life and predators was one of the main themes running through the whole convention as also was his belief that more research on this point was required. The hazards to bees for example were difficult to assess, birds proved to be less resistant than mammals and fish were quite susceptible to insecticides particularly the chlorinated hydrocarbons. The increasingly rapid introduction of pesticides has its disadvantages, one of them being that it gives little opportunity for carrying out independent tests particularly on the effects on beneficial insects. Another disadvantage is that it becomes increasingly difficult to find suitable common names for the new pesticides, indeed Dr. Martin felt that we may even come to the stage when there will be confusion between common names.

He concluded by stating that he felt that the formulation and application of crop protection chemicals should be correlated with the type of crop, etc., so as to exploit to advantage any difference in susceptibility between the pest and its predators and parasites.

One comment in the discussion which followed which particularly took our fancy came from Dr. Galley who, following a discussion on the resistance problem and the need to protect predators, commented that someone ought to investigate the possibility of breeding pest predators, resistant to insecticides.

Problems in the use of Insecticides

The second paper "Problems in the use of insecticides" was given by Dr. A. B. Hadaway, Colonial Pesticides Research Unit, Porton, who dealt with the subject so competently that for a brief moment it appeared as if no one would dare to raise any questions at discussion time.

Dr. Hadaway began by pointing out some of the benefits resulting from the use of pesticides, eg., the prevention of diseases, and increases in crop yields to feed the multiplying millions, adding a rider to the effect that in the latter case corresponding improvements in cultural practises must also take place especially in backward areas.

To obtain full benefits from the use of insecticides they must be put in the right place at the right time and no unwanted side effects must occur. To reach this end, a tremendous number of factors must be studied; factors which involve the close co-operation of research workers in many branches of science. Entomologists and ecologists must study the habits and behaviour of the pest to be controlled and its relationships with other fauna—particularly its predators and parasites—so that we can determine the right time and place for application, without unwanted side effects on beneficial insects. Chemists are required to produce the correct insecticide and formulation. Physicists and engineers are involved in finding the best method of application. Botanists may be required to ensure that no phytotoxic effects are required. Medical experts to assess the hazards to man. This is, of course, too simple an explanation for all these factors intermingle so that one cannot say where one science ends and the other begins, all must be considered as one complex variable system.

Dr. Hadaway went on to give examples of the effects of different types of leaf surface and meteorological conditions on different insecticides, the advantages and disadvantages of different drop sizes and hence to a brief discussion on high and low volume spraying. As could be expected no paper by Dr. Hadaway would be complete without reference being made to the manner in which different types of wall surfaces affect the biological efficacy of insecticides used for the control of such Public Health pests as mosquitoes. Like many others this paper wound up on the note that chemicals should be formulated according to the job in hand and that more research was needed.

Hazards and Precautions

The third open meeting on the Hazards and precautions associated with the use of pesticides attracted the largest attendance of the whole conference. Papers were given by Dr. J. M. Barnes, of the Toxicology Research Unit and Dr. E. J. Miller of the Plant Pathology Laboratory.

Dr. Barnes discussed the manner in which hazards arose and accidents occurred, somehow managing to treat this serious subject in a light hearted manner without detracting from its importance. Starting on a bright note he stated that whilst the use of pesticides was increasing the number of casualties had not kept pace. There are two main reasons for this (a) manufacturers, users and others have gained more experience of the way in which accidents occur and the treatment of casualties, and (b) the present trend, particularly with the organophosphorous compounds, towards the production of less toxic materials (although the trend with the chlorinated hydrocarbons tended to be in the opposite direction none were as toxic as the renowned parathion).

The key to the safe use of pesticides is plain ordinary commonsense. However, it must be remembered that commonsense has two requisites, intelligence and ex-

perience. Experience, in the form of early training and education in the use of pesticides, is essential, without it there can be no hope of safety. It is also important to maintain discipline throughout the whole operation from the preparation of the concentrate through transport, mixing and spraying to the final stage of safely disposing empty containers and thorough washing to remove all traces of the chemical from the equipment and the person.

Where complete protection is impracticable steps must be taken to reduce the amount of exposure. Discussing the various ways in which exposure occurs Dr. Barnes stated that for operators the greatest source of danger was dermal contact with the amount of pesticide inhaled or injested being insignificant to the amount falling on the neck, shoulders and arms. Public Health workers, who generally operate in confined spaces, for obvious reasons run a greater risk than field workers. The areas of the body which are likely to make contact with the pesticide must be protected and where wettable powders are being used good cotton cloth is as good as anything.

Referring to the fact that Concentrate handlers undergo the greatest risk of all, Dr. Barnes stated that as well as wearing rubber gloves, etc., they must also remember to thoroughly clean their gloves as pesticides may dissolve through them. We might add at this point that there was some discussion on this aspect and questions were asked as to whether natural rubber, synthetic rubber, or P.V.C. gloves should be used. Little information was available on this point but it appeared that the performance of each type depends upon the solvents of the pesticides being handled. Another interesting remark on this question was made by Dr. Edson, of Chesterford Park, who stated that operators must remember to *wash the inside of the gloves*, and who also recommended that unsupported rubber gloves should be worn as the cotton material used in supported gloves may act as a wick to draw the pesticide into the glove.

In his paper Dr. Barnes also discussed the problem of detecting degrees of exposure, the setting up of lines of communication, i.e. warning nearby hospitals and doctors that spraying is to be carried out, of the type of pesticide to be used and of the methods of detection and treatment. He also emphasised the need for adequate washing facilities and for manufacturers and advisory bodies to consider the human and mechanical organisation of the area concerned, when making recommendations for the type of pesticide to be used.

The paper concluded with an account of the way in which accidents have occurred from suicide, to the mistaken use of pesticide as hair oil, medicine, and self-applicated de-lousing agents.

Dr. E. J. Miller gave an account of the legislative and voluntary measures undertaken by organisations in this country to prevent the misuse of crop protection chemicals. Reference was made to the working of the new Crop Protection Products Approval Scheme, the Nalification Scheme, and the Agricultural Poisonous Substances (Agriculture) Act.

Research on Stored-Products Pests and their Control

Dr. D. W. Hall, Pest Infestation Laboratory dealt with The Organisation of stored products work within the commonwealth, Dr. J. A. Freeman, Infestation Control Division M.A.F.F., gave an account of "Stored Products and international trade" whilst the paper "Some problems in the use of insecticides against stored-products pests" was a joint effort by Dr. E. A. Parkin and Mr. A. A. Green of the Pest Infestation Laboratory.

Dr. Hall pointed out that with the improvement in world communications stored products pests were becoming increasingly important, a fact which only during the last few years had been recognised. However, more effort and International co-operation is still required even amongst Commonwealth countries which are ahead of other countries. This call for more research, and co-operation on an international basis was echoed in the other papers given at this session.

Unfortunately shortage of time appeared to hamper all the speakers, which is a pity as they all had something informative and interesting to say. No doubt the results of their efforts will be more apparent when the papers appear in print.

Biological Control

Mr. F. Wilson of the C.S.I.R.O. gave a most interesting account of the "Biological control of Insects and Weeds." He described the disadvantages resulting from the use of chemicals such as the development of resistant strains and even new pests, and stated that this was one of the reasons for the increasing interest in biological control methods. Other factors being the increasing interest in population dynamics and recent progress in the utilization of biological control agents.

Despite Mr. Wilson's faith in biological control and this reporter's own belief that it has a valuable part to play in crop protection it was evident that there is still a lot of research needed and many problems to be solved before biological control methods can be exploited to their full extent.

One of the greatest difficulties is persuading authorities to provide enough money for experiments and trials probably because it is difficult to prove that control has

been attained and results are difficult to assess; moreover, due to the present lack of knowledge it is often not known why a success is a success, or a failure a failure. In other words we cannot yet define the requirements of a biological control agent thus the result of introducing a bioligical control agent cannot be forecast. If we could define the requirements it may be possible to breed more efficient strains of predator. But again how can this be demonstrated to authorities who will have to provide the money for research.

Mr. Wilson also emphasised the need for international co-operation and suggested that a World Centre should be set up for the collection and dissemination of information, predators and parasites; a co-ordinated international programme to investigate the predators and diseases of common pests should be instigated.

Timber Boring Beetles

At the session on "Recent investigations on timber-boring beetles", J. D. Bletchly, Forest Products Research Laboratory, discussed the susceptibility of hardwoods to attack by *Lyctus* powder-post beetles, and methods of control, and Tecwyn Jones, East African Agriculture and Forestry Research Organisation, gave an account of "Ambrosia beetle research in West Africa." Both papers were interesting, but disruption of London's Transport system severely reduced the attendance. This was somewhat unfortunate for the absentees for Mr. Jones' method of reading a paper is most interesting and enjoyable.

Termites

"Termite control in afforestation projects" included a lively and interesting paper by W. V. Harris, Colonial Termite Research Unit, a competent paper by W. A. Sands, C.T.R.V., Nigeria, and an unscheduled display of lantern slides by a member of the audience.

Viruses

The session on "The utilization of pathogenic Viruses in the control of insect pests" included a paper of the same title by Dr. K. M. Smith, Virus Research Unit, Cambridge, and a paper by Dr. L. L. J. Ossowski, Wattle Research Unit, South Africa, dealing with "A virus disease in the biological control of the wattle bagworm."

This method of pest control is still in its infant stages but it holds great promise a fact which Dr. Smith demonstrates in no uncertain manner. Indeed personally speaking his paper was the highlight of the convention.

Two microlbiological agents—*Bacillus thuringiensis* and *B. pallidae* are already being used commercially in several parts of the world and with the aid of several excellent slides, Dr. Smith demonstrated some of the excellent results which have been obtained experimentally with other viruses. He classified these into 3 main types:

(1) Polyhedral viruses of which there are two main types, the nucleopolyhedral which forms rod-shaped crystals in the cell nudeus and causes the insect, as a whole, to melt, and the cytopolyhedral which forms spherical crystals in the cytoplasm of the cell, with the attacked insect drying out and leaving the cuticle intact.

(2) Granulous viruses.

(3) Free viruses.

All these viruses must be injested to take effect and hence will be most useful against plant-eating pests such as caterpillars.

However, a great deal more research is required into such problems as mass culture, distribution, classification and even the discovery of viruses. There is also a problem of storage, particularly with the Granulous and free viruses.

We must investigate the possibility of the development of attenuated strains and the development of insects resistant to a particular strain of virus. Another intriguing possibility is that in some cases where the use of a particular virus has resulted in the death of insects it has been found that death was in fact caused by another "latent" virus which was "triggered off" by the virus applied. This again is another field to be investigated.

Tsetse, Trypanosomes, and Locusts

Other sessions which we found interesting were:

(1) "*Recent advances and current trends in the study and control of tsetse flies and tryparasomiasis*" in which J. Ford, Department of Tsetse and Trypanosomiasis Control and Reclamation, S. Rhodesia, recounted the changes which have taken place in the approach to dealing with this problem, i.e. the fact that closer co-operation between entomologists, ecologists, parasitologists, doctors, veterinarians and others had led to a better knowledge of the relationships between tsetse and tryparosomiasis has led to improved methods of control.

In the same session Dr. K. S. Hocking, Colonial Pesticides Research Unit, discussed the use of insecticides in the control of tsetse fly emphasizing that greater knowledge of the tsetse flies habits had enabled the cost of control to be cheapened considerably.

(2) "*Recent Research on locusts and their control*" in which Dr. P. T. Haskell and Dr. R. C. Rainey dealt respectively with the physiology and behaviour of locusts and operational research.

Reflections on the Royal

TIME and again the circus has been referred to as "the greatest show on earth" but there are many, particularly in the agricultural world, who would put forward the Royal Show for the role of chief contender. In agriculture it is **the** show and it is not surprising, therefore, that everyone wants to get in on the act (even the Ministry of Labour was represented). They were all there, bankers, brewers, boyscouts, show jumpers, stockmen, shepherds, shooting stick sellers, pig keepers and the press. We must not forget the press for almost every section carries some report on the show even if it is only a single column inch inserted below the television programmes. Of course the farming press really go to town (?) with special Royal Show issues and supplements or very extensive coverage. Photographs are liberally distributed amongst the comments and reports, with new machinery and awarded winning stock taking up the majority of available space.

Unfortunately, no matter how well taken, these two dimensional, black and white images cannot convey the mood of the show; they cannot bring out the sleek, shining coat, the powerful majesty of an award winning bull or recall the points that delighted the stockman's eye. Machinery suffers rank injustice for the bright reds and yellows of the tractors, the shining silver of wheels and ploughshares, the bootpolish black of unblemished tyres and the impression of push button power is lost. At the show one can walk round these modern monsters, they can be touched, examined, pushed and prodded, some trick of the atmosphere leaves you with the impression of a living thing which bears no resemblance to the inanimate mechanised mass captured by the camera or, as someone ironically remarked, to the willing mud-stained slave of the farmer.

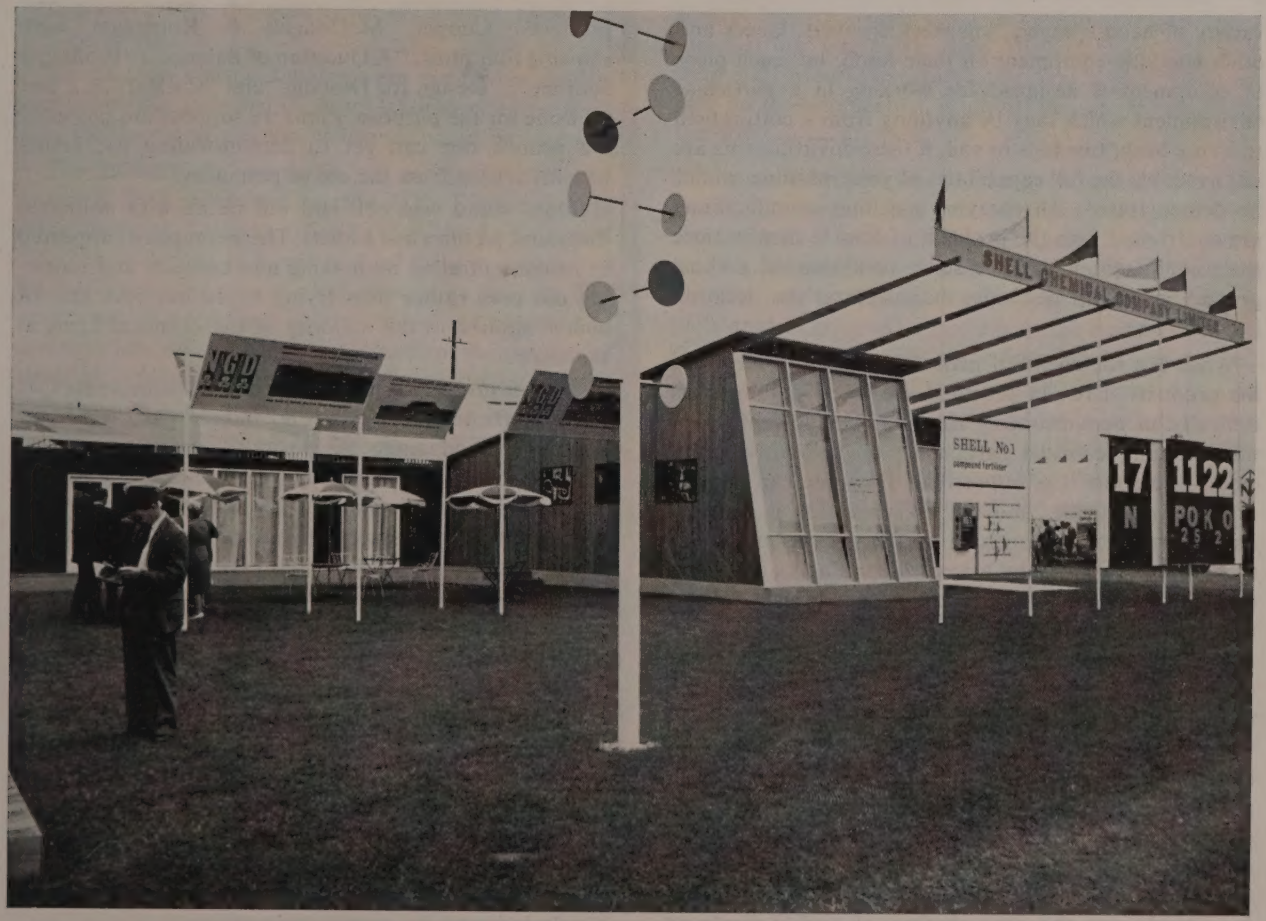
Why do machines such as tractors, harvesters, and hedge cutters receive so much publicity when other valuable aids to modern agriculture such as spraying machines and agricultural chemicals rarely receive a mention in Royal Show write-ups ? One could almost imagine that these big machines exerted some mysterious influence on the population as a whole and the press in particular, but there are logical reasons for this apparent lack of balance. One needs more than the allotted three days to take in everything, most people can only afford to spend one day at the show and tractors and the like are large and easily seen, moreover the exhibitors of such machines usually have a large area for their stand. It is not surprising that people with a short time to spend naturally gravitate to the larger exhibits.

There is another important point which must be mentioned, the advantage of using these machines is easily demonstrated but the benefits of using insecticides and weedkillers are not. One can immediately assess the profits that will be obtained from the use of a harvester, but it takes practical experience, often over more than one season, for a farmer to realise that weedkillers may be essential in order to make the fullest and most economic use of such a harvester.

This inability of the pesticides industry and allied organizations to demonstrate their wares is a vexing problem. Who would guess from reading the farming papers that over 45 exhibitors were concerned in some way with the manufacture and marketing pesticides or the equipment for their application. Twenty-six of these marketed insecticides, thirteen sold fungicides and twenty three manufactured spraying machines or other devices for the application of insecticides. These numbers compare favourably with the tractor manufacturers (21) and irrigation plant manufacturers (11) both of whom received a fair degree of free publicity in the press, yet if the spraying machine or pesticides manufacturers received any such publicity we have missed it.

If the eye-catching "whiter than white" of Drake & Fletcher's Victair air assisted medium/low volume sprayer, the conspicuous yellow of Chafer's crop dusters and the burnished copper of the Four Oaks Knapsack sprayers fail to attract the camera man's eye what chance is there for the others ? Again even if you can attract attention, how can you demonstrate the capabilities of your machine ? How could Dorman Sprayers show their "no drift" system which can only be appreciated after actual experience ? Cooper Pegler had an immense

No prizes for guessing the owners of this stand which appeared much more lively and palatial when viewed in three dimensions.



Shell Chemical Company's Royal Show stand.

Imperial Chemical Industries' impressive edifice

variety of hand sprayers, knapsack sprayers, lances and other spraying equipment on their stand, but each piece of equipment is designed for working in a particular environment which may be anything from a cotton field to a rose bush, tree tops or soil, if these environments are not available the full capabilities of your machine cannot be demonstrated. All spraying machine manufacturers are confronted with the problem of how to demonstrate their equipment under the static condition of a show ground but for the pesticides manufacturer the situation is even worse.

What can the chemical manufacturer do to advertise his products. Even in practical use there is sometimes difficulty in demonstrating the economic advantage of using certain pesticides particularly the preventive pesticides, at a show it is impossible. True one can show a drum of insecticide, and tell everyone that it will kill insects over such and such an area, one can show weeds that have been killed by a weed killer, facts and figure can be related, photographs can be shown but you cannot show the chemical actually doing the job. Chemical manufacturers, therefore have to rely on some indirect method of catching the prospective customer's eye. Such firms as Fisons, Shell Chemical Company, Imperial Chemical Industries, Cooper, McDougall & Robertson and Boots had large impressive stands in excellent positions near the grand ring. On their site Fisons had erected a two-storey building which was quite palatial in appearance, and the stands of the other firms were not far behind in elegance. Another notable feature of these five stands was the near absence of visibly displayed products. Cooper, McDougall & Robertson were showing four films: "A Question of Balance", "Profitable Journey", "Design for Dipping" and "Co Ral" in a tent set aside for the purpose. Films we suppose are probably the nearest one can get to demonstrating the actual benefits arising from the use of pesticides.

Boots' stand was well laid out inside with animated diagrams, pictures and leaflets. These companies appeared to be concentrating on making new contacts and renewing old ones rather than trying to do business, this of course applied to the majority of the chemical firms at the show.

Other firms such as the Standardised Disinfectants Co., Dow Agrochemicals, May & Baker, etc., were not allotted such advantageous positions, their sites were, in general, smaller and naturally large eye-catching edifices could not be erected. On the other hand they had more of an air of personal contact, anyone could walk in and out whereas on the larger more lavish stands, the public may have gained the false impression that they needed an invitation card to enter.

Whatever the type of stand, whether it was small and hidden or large and obvious they all appeared to be doing well with regard to making new friendships and cementing old ones. As for business, well as one person put it, "Who goes to the Royal Show to do business."

However, there appears to be hope yet, for despite the fact that shows are unfavourable for the demonstration of pest, disease and weed control methods; the very fact that there were some 45 firms exhibiting in this field surely indicates its growing importance.

RESISTANCE OF BLATTELLA GERMANICA TO DIELDRIN

By J. M. G. GRADIDGE, (*Infestation Control Laboratory, Ministry of Agriculture, Fisheries and Food*)
Hook Rise, Tolworth, Surbiton, Surrey.

THERE have been various reports from overseas and particularly from the U.S.A. that the German Cockroach or Steamfly (*Blattella germanica*) has become resistant to dieldrin, chlordane and other chlorinated hydrocarbon insecticides. However, although we have heard suggestions that resistance was occurring in the United Kingdom, no record of any cases in this country appears to have been published. Recently the opportunity occurred to carry out tests on insects collected from two places where the occurrence of dieldrin resistance was suspected.

Insects were collected which were resting on dieldrin lacquer bands, and used to set up laboratory cultures, so that the degree of dieldrin resistance could be assessed.

The method used to assess the resistance level was basically that developed by the U.S. Department of Agriculture at Orlando, Florida, for the U.S. Armed Services. A deposit of 5 mg/sq. ft. of dieldrin is obtained by evaporating an acetone solution within a glass jar. The insects are then exposed within the jar and observed at frequent intervals, a record being made of the number of dead or moribund insects at hourly intervals. The test specifies that adult males be used, since they are the most susceptible, taking less than half as long as females to die.

Normal susceptible insects from stock cultures maintained at Tolworth were all dead or moribund after less than two hours exposure to the dieldrin deposit, but few of the resistant insects were dead after a 48 hour exposure, indicating that there was a considerable degree of resistance in both cases.

The first report concerned a ship which had been treated regularly with dieldrin lacquer since 1954, about a year after regular treatment of ships with lacquers started. The ship had visited the U.S.A. at intervals since 1956 and may possibly have obtained resistant insects from that country: on the other hand the resistance was quite likely to have been acquired on the ship as a result of the manner in which it was tested. Although every part of the galley and crew quarters were treated more than once between 1954 and 1959, it was never possible to make a complete treatment at any one time. Furthermore treatments were often obscured by repainting or by grease deposits. Thus, the insect population was never exposed to an adequate deposit of insecticide. Sufficient insecticide free areas were always available to permit breeding, and the treatment probably did little more than kill off all but the least susceptible insects, which remained to breed. Between 1954 and 1959 control was reasonably good, but during the past twelve months four treatments were called for, and survivors were still to be found, indicating that a population has now been selected which is almost immune to dieldrin at the doses normally used.

The second report was from a government building in the London area, where treatment has been carried out since 1956 in a restaurant open 24 hours a day. Dieldrin lacquer and dust, chlordane emulsion and DDT dust had all been used at various times, but at no time was complete control achieved. Once again, the main reason was the difficulty of carrying out a complete treatment. This was partly because of the 24 hour working, but also because the structure of the building is such that some breeding sites could not be reached. Early in 1960, when the *Blattella* population began to increase in spite of frequent treatments, resistance was suspected.

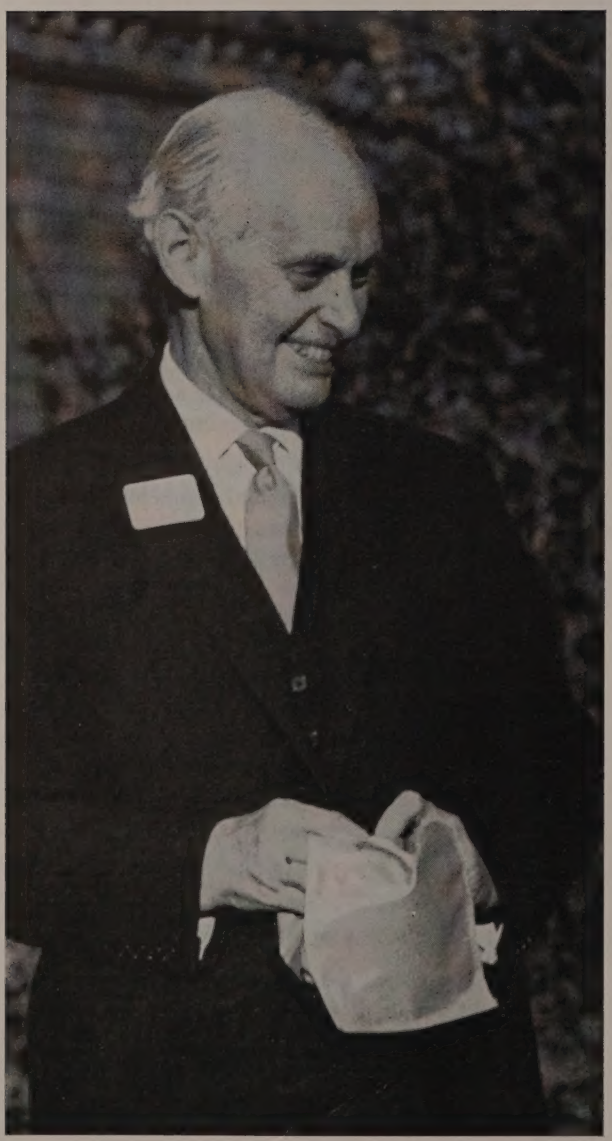
This note is to draw the attention of your readers to these cases since others may well occur during the course of their servicing or other work.

The two cases discussed above are isolated examples, and it should not be assumed that all *B. germanica* are resistant to dieldrin or chlorinated hydrocarbon insecticides. It should also be noted that *Blatta orientalis* (the Oriental Cockroach) has not been reported to be resistant to any insecticides so far.

The possibility of using alternative insecticides is under investigation at the Pest Infestation Laboratory and it seems likely that it will be possible to use an alternative method of control.

B.W.P.A.

Annual Convention



Mr. B. Hickson, President of the B.W.P.A. caught in informal mood.

ANYONE who has the dubious honour of arranging the annual convention of a professional, scientific or any other organization should contact Mr. Wm. E. Bruce, Secretary of the British Wood Preserving Association for guidance. Year after year this organizing genius continues to arrange the Association's annual convention as near perfection as one can get.

There is an excellent balance between general and scientific papers, enough scientific information and data to stimulate the mind without over-loading it and, with the distribution of pre-prints of the papers before the convention, enough time for discussion of each paper. On this occasion, the 10th Annual Convention, Mr. Bruce also took on the additional task of reading a paper to the convention.

Following the formal procedure, Mr. B. Hickson, M.Sc., F.R.I.C., President of the Association, opened the convention with a speech in which he welcomed delegates from home and overseas. He also mentioned some of the Associations' activities during the past 12 months with two important pieces of work—the preparation of the Code of Practice relating to Remedial and Curative treatment of timber, and the Preparation of an advertising code which will contain an agreed statement of ethical principles on publicity—receiving particular attention. The purpose of the latter, which has been developed by the Association in conjunction with the Timber Development Association, is to provide advice for members of the Association and those of the T.D.A. who are interested in commercial advertising.

Continuing, the President stated that timber is the oldest traditional building media in history, but in the past two or three decades it has become increasingly subject to competition from other structural products and particularly in recent years from some of the new synthetic products, therefore, we must expand our knowledge about wood itself so as to maintain and if possible increase its position in the industry dealing with construction in all forms.

Papers

All told six papers were presented at the convention, and all were most interesting. However, the three following papers, which are in abstract form, will, we believe, be of especial interest to our readers.

A section of the audience taken during the President's opening address

THE ECONOMIC ECOLOGY OF SOME TREE BORING BEETLES OF TROPICAL AFRICA

by TECWYN JONES, B.Sc., A.R.C.S., F.I.W.Sc., F.R.E.S.
(*East African Agriculture and Forestry Research Organization*)

Summary

This paper deals with some of the more important obscure groups of the Platypodidae, Cerambycidae and Lamiidae which infest living trees in East and West Africa. The biology and methods of infestation of a typical aberrant ambrosia beetle, the Cerambycid *Oemida gahani* Distant, and a recently discovered borer of *Isoberlinia scheffleri* Harms, are described in some detail.

An account is given of the factors influencing host susceptibility and those which determine the success or failure of borer attack. The natural immunity of living trees is discussed and the significance of living and dead tissues analysed. It is suggested that natural protection in a living tree results, not only from physical barriers such as sap flow and resin or gum exudations but also from the sub-normal respiratory conditions which prevail in saturated sapwood.

Attention is drawn to the importance of unfavourable ecological conditions, insolation, game damage and silvicultural practices in providing favourable host conditions for the pests. The consequences of attack are described and possible control measures discussed.

Introduction

Wood is subject to destruction by insects in all its stages. The significance of insect depredations of felled timber is fully appreciated and concern is also shown over certain insect attacks, e.g., epidemics of caterpillars, bark beetles, weevils, etc. These problems are, however, known and can be detected and dealt with. The tree borers described in this paper are generally unknown and usually unseen no doubt due to their cryptic habit. The onset of attack generally passes unnoticed.

The insects in question are alike in biology only and hence are not confined to one family or one order. Some of them, e.g. *Dendroplatypus impar* have been known for a considerable time but it is only recently that the tree borers of East and West Africa have been accorded full attention. Of these, some such as *Oemida gahani* are now fully described and identified but others, e.g. the *Isoberlinia* borer of Tanganyika are only known by their depredations. In either case, the borers, named and unnamed, on account of their obscure life present certain common and, as yet unsolved problems.

Biology of the Borers

(*i*) *Platypodidae* (*Ambrosia beetles*). The family as a whole is confined to freshly felled logs or green lumber. Nevertheless, some species are apparently capable of boring into healthy living trees. Known examples are *Symmerus tuberculatus* Chap and *Trachyostus ghanaensis*. Schedi infesting Wawa/Obeche (*Triplochiton scleroxylon* K. Shum); *Symmerus Montanus* Schedl. boring into healthy *Olea welwitschii* and several species of *Doliopygus* infesting vigorous trees of *Cynometra* and *Albizia*.

The whole of their biology conforms to the same basic plan and their method of entry into the host, i.e. via a radially directed tunnel excavated by the male which traverses the sapwood of the living bole, their breeding and feeding habits are identical to those of other Platypodidae and have previously been described.

Losses in volume of timber arise from extensive tunnelling of the heartwood by the female. If the tree is

Caught in the middle! D. Boocock, Technical Director, Preservation Developments Ltd., appears to be the referee in a battle of words between H. A. Cox. B.W.P.A. (left) and Tecwyn Jones (right), East African Agriculture and Forestry Research Organisation.

attacked in its early years then it is the innermost heartwood of the mature tree which suffers, whereas if infestation occurs only a few years before felling then only the outermost heart suffers degrade. Obviously periodic attacks over many years, even if few and far between, cause the greatest degree of destruction as extensive tunnelling of the heartwood cannot be overcome even by the most careful conversion. Losses in value particularly for blonde hardwoods, also result from the activities of the wood-rotting and wood-staining fungi which line the ambrosia beetle galleries and subsequently spread to the sound wood.

(*ii*) *Longhorn beetles.* This very large group, embracing the Prionidae, Lamudae and Cerambycidae includes some of the best known forest insects and the most renowned timber pests. They are as diverse in habit as they are in choice of habitat and not the least spectacular among them are those which bore in living trees.

Oemida gahani was the first of these to be discovered in the first instance as a pest of structural timber. To date *Oemida* has been recorded from more than 100 host species, all soft woods, of which 80 or more are indigenous to East and West Africa. Other subsequently discovered borers include the Cerambycid *Androeme plagiata* Auriv which is like *Oemida* in appearance and biology and which infests living hardwoods and conifers on the Usumbara mountains of Tanganyika. In Western Uganda a large percentage of living *Parinari holstii* Engl., one of the hardest and most durable indigenous timbers, was found to be infested with an unknown lamiid longhorn. The *Parinari* borer, as it is so aptly called, is still unidentified at the time of writing. Another large borer, now identified as a species of *Pachydissus*, is responsible for extensive heartwood destruction of *Cynometra alexandri* Wright., in Uganda. Very recently two Tanganyika timbers *Isoberlinia scheffieri* Harms and *Syzygium cordata* Hochst., have been abandoned by sawmillers in the Tanga Province. The exploitation of these timbers is quite uneconomical on account of the destruction of their heartwood by an unknown longhorn borer. The sawmillers claim that over eighty per cent of all the trees are found, on felling, to be completely worthless.

Existing knowledge of the biology and ecology of these individual borers is scant, but as there are good grounds for assuming that they do not differ fundamentally in behaviour to *Oemida* and the *Isoberlinia* borer these two may permissibly be considered fairly typical of all the known species boring into living trees.

Host Susceptibility and Immunity

When attacking a living host, the female Oemida oviposits on the exposed deadwood of broken branches and damaged areas of the bole; though in the case of plantation softwoods pruning scars are the usual egg-laying sites. The eggs, in batches of twenty or so, are just visible to the naked eye and are glued together and to their host, by mucilage. Incubation takes one to several months depending on conditions, and the young larvae always emerge on the host side of the egg mass. In this way they are able to bore into the adjacent host tissues without exposing themselves. The entry tunnel, like the larva itself, is of very small diameter and is usually obscured by the egg mass. This tunnel like all future ones, is tightly packed behind the larva with a fine granular frass, compacted to a very hard consistency.

Throughout its borings the larva carefully avoids all living wood and confines itself to heartwood or dead sapwood. If located by fate in a dead but isolated portion of the bole surrounded by living wood, then the larva is unable to extend its borings beyond the limits of the dead tissue and must complete its life cycle in this confined area. When located, as is more common, in a pruning scar or broken branch, the larva is able to penetrate right into the heartwood centre of the tree. Once there, the larva proceeds to bore vertically up or downwards until, after several moults, it comes to rest in the outer heartwood adjacent to external dead tissue, and there it pupates. The adult, like the larva, avoids living wood and bores its way to the exterior through an oval emergence hole. Apart from this exit hole, which measures approximately 2 mm. by 5 mm. in diameter, the infested tree itself shows no evidence of the pests within it, because the depredations of the latter are confined to the heartwood and do not interfere with normal growth and the appearance of the tree.

The case of the *Isoberlinia* borer, appears from recent investigations to be very similar to that of *Oemida* though the end result is far more spectacular. The larva, like that of *Oemida*, avoids all living tissues and penetrates to the heartwood core of the main trunk and commences to burrow vertically. In its later stages the

larva attains considerable dimensions and a minimum diameter of half an inch with tunnels of equivalent size. In addition, whilst boring vertically the larva has the habit of extending its tunnels parellel with the growth rings of the tree. As a result tunnels measuring half an inch in minimum (radial) diameter and four or even six inches in maximum (tangential) diameter are not uncommon. Where numerous borers occur in the same tree, as is not unusual, the destruction of heartwood is appalling, the ratio of holes to sound timber is high, and the tree is valueless except as fuel.

Unlike *Oemida* which ingests all, and digests at least part of the wood it excavates during tunnelling, the *Isoberlinia* borer is wantonly wasteful. Its tunnels are tightly packed with large coarse wood fibres, uneaten and undigested they are cast behind the larva and only a very small proportion of the wood excavated is used as food.

The extent of tunnelling by any one individual larva in the heartwood of a living *Isoberlinia* has not been determined, but in the few cases observed to date, infestation has extended through the entire length of the bole, i.e., all of eighty feet, from the butt to crown. Examination of crosscut surfaces of logs has confirmed that the tunnels may occur anywhere, from the outer heartwood region to the very centre of the trunk in living trees, and occur even in the sapwood of dead trees and old logs.

It is highly significant that where wood borers successfully infest living trees, the insects live and thrive in the heartwood of their hosts and assiduously avoid the fully-functioning and saturated sapwood. This is true of all the borers mentioned above, though it is less apparent in the *Platypodidae* than in the case of *Oemida* and the *Isoberlinia* borer. It indicates that whereas the heartwood or its equivalent, of a living tree is an ideal source of food and shelter for the borers, saturated sapwood is unsuitable.

Where the tree presents no heartwood or deadwood on its external surface as is the case in an undamaged and unpruned tree, infestation by *Oemida* and similar borers does not occur.

In the case of Platypodidae, completely dead wood is not necessary for successful infestation, and the beetles can penetrate through sub-vigorous or dying sapwood. Like the other borers, however, they too are unable to penetrate or live in fully functioning sapwood.

There is no doubt that the biggest single factor in the prevention of borer attack on living trees is the possession by the trees of an outer protective layer of virile living sapwood. If this remains intact and its efficiency remains unimpaired, the tree is immune to infestation by wood-boring insects.

The most obvious reason why thriving sapwood is not inhabited by the borers is the sub-normal respiratory conditions although, other factors such as the embalming of insects with gum or resin may have a part to play.

Conditions Necessary for Successful Infestation

In the case of *Oemida* there must be exposed heartwood or deadwood available to the insect. This can take the form of broken branches or pruning scars and wounds, and if it is not isolated by living tissue the insect will penetrate to the heartwood core of the tree. In the case of Platypodidae, recently damaged, sickly or dying wood and particularly sub-vigorous sapwood must be available for the adult to effect entry.

These broadly speaking are the conditions most conducive to successful infestation. They occur in nature more frequently and more extensively than is usually realised. The ravages of wind and storm provide exposed heartwood and deadwood in broken branches, abrased stems and damaged boles. Damage by animals such as monkeys and rats does likewise, and in East Africa the depredations of elephant and buffalo are particularly serious. The former tear off wide strips of bark from around body height to the top of the tree, and the sapwood so exposed usually dies. Buffalo accomplish similar results by rubbing the bark off with their horns.

Conditions such as suit the Platypodidae in particular i.e. loss in vigour of the sapwood, may result from any of the above causes and many others besides.

Nature, then, of its own accord, provides limited opportunities for each type of borer to infest living trees. Man, in his attempts to exploit and then enrich the forest has increased these opportunities multifold. By felling and clearing he has provided abundant breeding material for the pests and they in turn have multiplied and infested damaged standing trees or those weakened by age, insolation or fire. Such conditions may well have led to the establishment of *Cynometra*, *Parinari* and *Isoherlinia* borers as well as the arberrant Platypodidae. Even so, these circumstances are of minor importance relative to the ideal conditions for borers provided by plantations and their accompanying silvicultural practices. Regular and systematic pruning, for example, is a feature of plantation silviculture, and the pruning scars, which may take several years to occlude, provide an abundant and constant supply of exposed heart or dead wood for the *Oemida* type borer. The close proximity of similar host species ensure the emerging generation of a suitable host on which oviposit and the future of the next generation is likewise assured and so on *ad infinitum*.

Control Measures

The control of borer infestations in the indigenous mixed forests of the tropics is extremely difficult and can hardly be contemplated.

In plantations control measures are feasible and investigations of ecological and chemical methods of preventing *Oemida* infestations in East African plantations have been under way for sometime.

In the field of ecological control investigations have

been numerous but by far the most successful measure has been the change over from *Cupressus* to a less *Oemida*-susceptible tree. At present certain *Pinus* species seem most promising and appear to provide a satisfactory quality and quantity of borer-free timber.

Chemical control studies have been directed at developing an effective coating for pruning scars and wounds, with the idea that this coating would be applied at the time of pruning. Ideally this coating should be highly repellent to the adult beetles and so prevent the female alighting on the scar to oviposit. Secondly, in case oviposition does take place the protective coating should be an efficient ovicide and finally as a safeguard it should be larvicidal also. Above all however, it must be persistent and fully effective from the time of application to the occlusion of the scar. To date, bitumen compound shave given excellent persistency and have remained intact without cracking or flaking for more than eighteen months.

Notable points arising from the discussion of the paper included the fact that *Oemida* will attack seasoned timber if its natural habitat is denied it and it can become a serious pest. It is also possible that the *Isoberlinia* borer could do likewise.

Dr. N. E. Hicken

AN INTRODUCTION TO THE STUDY OF THE BRITISH LYCTIDAE

by N. E. HICKEN, Ph.D., F.R.E.S., F.I.W.Sc.

(*Technical Director, Rentokil Ltd.*)

The main value of this paper in the opinion of many will be to students or entomologists entering the field of wood preservation. It will serve as a useful key for the identification of Lyctus beetles. This abstract account briefly gives an account of the information contained.

Introduction

The objects of the paper are twofold. Firstly, it is desired to provide descriptive illustrated keys for the identification of the adult stages of those beetles of the family *Lyctidae* likely to be considered British, and, secondly, to provide a general account of the biology of this group with special reference to their importance in Wood Preservation.

The *Lyctidae* together with the *Bostrychidae* are known as powder-post beetles on account of the larval habit of burrowing into the sapwood of susceptible hardwoods, until nothing is left but a fine powder. This may take several generations but a thin veneer of the wood on the outside is left unsupported from the inside. This uneaten veneer may burst and become detached. The outer veneer does, of course, show the flight holes made by the mature beetles.

Position of the Lyctidae in Coleoptera Classification

The *Lyctidae* together with the families *Anobiidae*, *Ptinidae*, and *Bostrychidae* are at present included in the super-family Bostrychoidea, which in turn is included in a larger group of Coleoptera, namely the Polyphaga.

The larvae of the families in the Bostrychoidae are similar in general shape, being crescentic. They are soft, having no sclerotised dorsal plates. The wood-boring larvae in the group are enlarged at the anterior end, the abdominal segments progressively narrowing. The posterior segments are larger but not so large as the thoracic segments. The larvae of *Lyctidae* may easily be separated from those of the other familes in the super-family by the possession of enlarged spiracles on the eighth abdominal segment.

The adults of *Lyctidae* may be differentiated from those in other families in the Bostrychoidea by absence of hood-like pronotum characteristic of the Bostrychoidea as a whole and, by the club-like extremity of the antennae. In the *Lyctidae*, this club consists of two antennal segments only whereas in the *Bostrychidae* and *Anobiidae* three segments are involved.

World Distribution

The family *Lyctidae* consists of twelve genera and altogether sixty three species have so far been described. Each of the world faunal regions has its own indigenous

Lyctid genera with which is found a Lyctid fauna originally derived from other regions, but now introduced and established through commerce in timber.

British Species

Great difficulty is encountered in determining which species can be considered British. It now seems virtually certain that the only true indigenous species is *Lyctus liniaris* Goeze; *Lyctus brunneus* Stephens being an introduction from N. America some time around the nineteenth century. Kloet and Hincks, also list the following as established introductions:

Lyctus sinensis Lesne 1911
Lyctus planicollis Leconte 1854
Lyctus cavicollis Leconte 1866
and
Trogoxylon parallelopipedum Melsheimer 1846

In Kloet and Hincks the last named species is included in the genus *Lyctus*.

The problem is further confused by the synonomy (discussed by Dr. Hicken) which has accompanied the study of these insects and lack of agreement on the criteria constituting an established introduction.

Pre-Oviposition Examination of Wood

Oviposition normally takes place at night but first of all there is a pre-oviposition examination of the wood in which the female bites the wood transversely—giving rise to the so-called "tasting" or "feeding" marks.

The "tasting" marks appear to have two functions (a) to determine the nutritional value of the wood (the female does not lay eggs in sapwood containing less than 3% starch in the xylem parenchyma), (b) to open up further vessels in which the eggs can be laid (the actual oviposition site is invariably the lumen of a xylem vessel; the larger proportion, are, of course, exposed in the end grain). The relative importance of these functions is subject to some diversity of opinion which is discussed by the author.

The author continues with an account of oviposition and the development of the larvae to the adult stage pointing out that *Lyctus* larvae subsist on cell contents, utilizing starch as the main food stuff supplemented by certain sugars, disaccharides, a polysaccharide and some protein. Cellulose, pentosans and lignin appears to remain unchanged after passing through the larvae gut.

Other points of interest are that the size of the larvae varies within wide limits but 5 mm. appears to be the maximum length. The length of the life cycle varies widely according to temperature, moisture content of timber, etc. In Britain the probable length of the life cycle of *Lyctus brunneus* is probably one year, but in optimum laboratory conditions of 25°C. and 75% R.H. a complete life cycle is undergone in ten to twelve weeks. Under adverse conditions the life cycle may take from $2\frac{1}{2}$ to 4 years or longer.

External Morphology

Lyctid beetles are small, none of the British species exceed 7 mm. in length, and the colour range passes from reddish-chestnut through brown to black. They are devoid of marks. In shape they are elongated, rather cylindrical but flattened somewhat dorso-ventrally. The head is distinctly visible from above (in Anobiidae the head is not visible from above) and slopes downwards at an angle. The vertex is rugose or punctate. The eyes are prominent, hemispherical but with the posterior margin

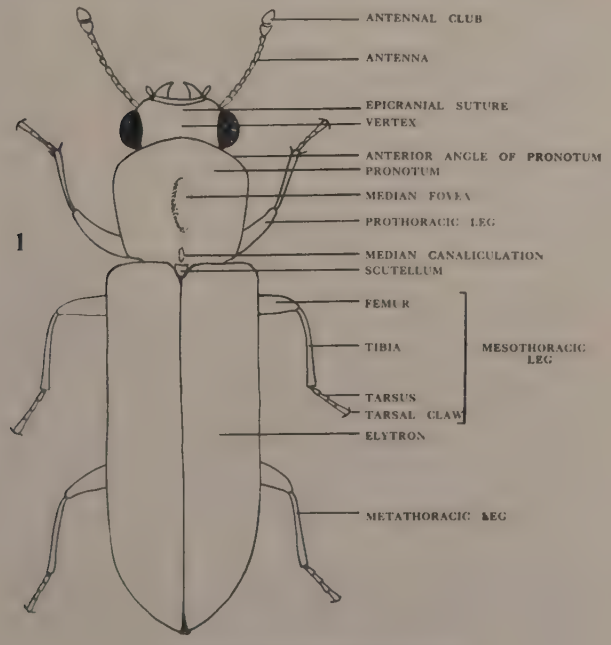


Fig. 1. General Lyctid beetle, diagrammatic, dorsal aspect.

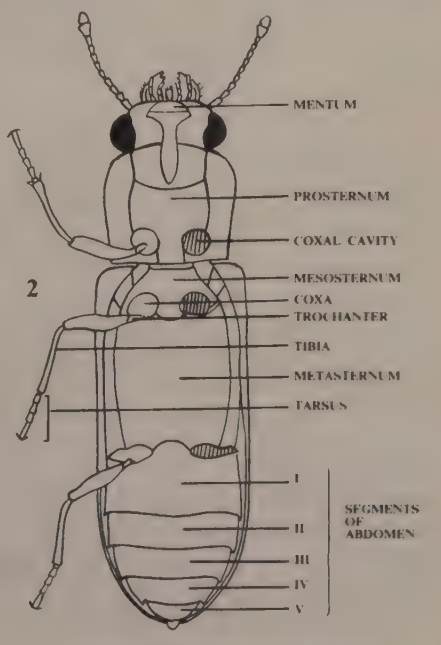


Fig. 2. General Lyctid beetle diagrammatic ventral aspect

flattened. The antennae are claviform, of eleven segments and inserted just anterior to the eyes. The club consists of two segments. The bidentate mandibles are heavily sclerotised, broad and robust at the base and there is a brush of setae on the outer face. The other mouthparts are illustrated, but the labial palpi are three-segmented whilst the maxillary palpi are four-segmented, the lacinia fringed and the galea, two-segmented.

The pronotum is roughly quandrangular, convex but with a median depression (median fovea). The curvature of the anterior margin varies in the different species as well as the shape of the anterior angles. The posterior angles are usually toothed. Light-coloured pubescence is present which may vary in texture.

The elytra are long and slender, and in the genus *Lyctus* there is a series of longitudinal ridges bearing fine hairs, and between the ridges rows of more or less regularly-disposed punctuations. The wings conform to the general pattern displayed by the Bostrychoidea but an anal lobe is present which is characteristic of *Lyctidae* within this super-family. The legs are slender and in the prothoracic legs the tibiae bear one or two short stout spines distally. There are five tarsal claws but the first in each case is very small.

Neither the male nor the female genitalia are sufficiently differentiated to serve as means of identification as occurs in many other groups of insects.

Description of British Species

Lyctus brunneus (Stephens 1830)

This is by far the commonest Lyctid in Britain and can now be considered cosmopolitan being found in all faunal regions of the world. It is extremely variable in size with lengths from 2—7 mm. having been recorded. There is also great variation in colour from very dark brown to reddish, the pronotum usually appearing darker than the elytra.

Antennae about the same length as pronotum with basal two segments enlarged. Last but one segment of antennae shorter but wider than the last segment. Pronotum wider at the front than behind, the anterior angles being rounded but distinct. The front of the pronotum as wide as the abdomen and except for a depression in the disc (median fovea), covered with fine hair. The fovea possesses two lateral arms which diverge towards the front. The whole of the pronotum is heavily punctuated giving the lateral margins the appearance of fine denticulation. There is a pronounced tibial spur.

The elytra have a series of longitudinal parallel ridges, being divided by rows of punctations. Between the elytral suture the first ridge are five rows of punctations, between the next ridges are two rows, but thereafter only single rows of punctations which separate the ridges. On the ridges and between the rows of punctations are longitudinal series of fine light-coloured hairs.

The female can be distinguished from the male by possessing a pencil of hairs on the fifth sternite—absent in the male.

Lyctus cavicollis (Leconte, 1866)

This is a North American species which can be easily overlooked by reason of its resemblance to *linearis* (Goeze) and to *planicollis* Leconte. The characters by which it can be differentiated from these species are as follows:—

The pronotum is rectangular and has the lateral margins almost parallel (converging slightly posteriorly) and sharply angled posteriorly. The anterior angles, although rounded, are distinct.

The punctations of the pronotum are separate and the whole of the pronotum except the median fovea, is covered by fine long hairs.

The elytra possesses a series of longitudinal ridges on each of which a single series of fine hairs arises. Between ridges there is a double row of punctations.

It is possible to separate the sexes by examination of the fifth abdominal sternite. In the female it is triangular and on each side of the median line there is a triangular patch of hairs. In the male, the fifth sternite is rounded and hairs of the apical fringe are not arranged in triangular patches. The size varies from 2.5 to 5 mm.

Lyctus linearis (Goeze)

Since 1777 when Goeze described this insect, it has received many synonyms which are listed by Gerberg. This native species was at one time the commonest of our Lyctides, but for some years *L. brunneus* has preponderated.

The frontal lobes are broad and prominently elevated which is an important character in differentiating this species from *L. cavicollis*. The antennae are longer than the pronotum and the basal two segments are enlarged.

The roughly quandrangular pronotum has rounded anterior angles, and the posterior angles are toothed. The lateral margins converge posteriorly. The disc is rugose with a deep median fovea which is circular and edged with long coarse hairs.

Elytra are about three times as long as wide and the longitudinal ridges with a single row of fine hairs are separated by a single row of large ovoid punctations except between the first pair of ridges, counting from the median line where the punctations vary between one and two series. The elytra are rust-red, but the punctations are black, legs are light brown.

The sexes can be differentiated by the female having the fifth sternite more slender and tapering whilst in the male it is broadly and flatly rounded.

The length varies between 2.5 and 5 mm.

Lyctus planicollis (Le Conte)

There is some doubt as to the correct name of this insect. It would appear that *carbonarius* Walth 1832

named from Mexican material should have priority but Gerberg retains *planicollis*.

The species is North American in origin where it is widespread, and is often reported from *Quercus*, hickory and ash.

Characters which distinguish this species are—pronotum wider than long and the punctations are distinctly separated. It can only with difficulty be differentiated from *cavicollis* and when series are bred the characters often overlap. The tenth antennal segment is wider than it is long, whereas in *L. cavicollis* this is not so. Length is not so variable as in some species, being four to six mm. Colour, black—shining where covering of fine light-coloured hairs is rubbed. Antennae are as long as the pronotum and the legs are reddish.

The females possess a fringe of long setae on either side of the median line of the fifth sternite. The males have a rounded fifth sternite the apical margins being fringed with setae.

Lyctus sinensis (Lesne)

This is an Asiatic species, Japan being a usual source of infestation. The pronotum is less in width than the elytra and the lateral margins converge posteriorly. It has reticulate punctations and the fine light-coloured hairs are thicker and longer on the pronotum and the head than on the elytra. The lateral two-thirds of each elytron is lighter in colour than the median third. In the latter area longitudinal ridges are absent and hairs are sparse and punctations are irregular.

T. parallelopipedum can be readily differentiated from other Lyctids occuring in Britain by the anterior angles of the pronotum being very prominent and acute, the postclypeus being rounded and depressed and the abrupt expansion of the antennal club. The antennae are slightly shorter than the pronotum and the latter is slightly wider than long. The base of the pronotum is approximately equal in width to the elytra. There is a shallow Y-shaped depression in the disc. The anterior margin of the pronotum is strongly convex and the posterior angles are prominent and acute. The prothoracic coxae are widely separated. The elytra are about twice as long as wide, and widen slightly posteriorly.

The length varies from 2.5 to 2.25 mm. This species is widely distributed throughout North America from whence it no doubt entered British ports.

Economic Importance of Lyctidae

Lyctidae are polyphagous and the majority of commercial hardwoods are liable to attack. Those with plentiful vessels of adequate diameter are more likely to be attacked by Lyctus than where such vessels are not so plentiful, provided, of course, that the nutritional factor is present.

In most countries of the world *Lyctus* beetles are of economic significance and they are found infesting a wide range of wooden structures. In Great Britain *Lyctus* damage was most widespread soon after the first world war. *Lyctus* damage again appeared to increase during the later stages of the last war and again caused many losses, causing embarrassment to the hardwood timber industry and many furniture manufacturing and distributing concerns. Since that time, the growing use of tropical hardwoods many of which are highly susceptible to *Lyctus*, has resulted in new infusions of the Cosmopolitan *Lyctus* species into these islands. Although the *Lyctus* problem in Great Britain is small compared with that of *Anobium punctatum*, it is, nevertheless, substantial.

THE BRITISH WOOD PRESERVING ASSOCIATION—A PROGRESS REPORT

by Wm. E. Bruce, M.A., F.I.W.Sc.,
(*Secretary, B.W.P.A.*)

This report covers the activities of the Association over the past 10 years, and as these activities have been many the paper, in its original form was restricted to the minimum amount of words. The following account, therefore, can only be considered as indicating a few points which attracted our attention more than others.

Introduction

Briefly speaking the aims of the Association are:-'To investigate and discover and to acquire, collect, promote, and spread knowledge of all kinds of methods of preserving wood, whether by treatment or otherwise, for fire proofing and of preventing wastage of timber and in particular to promote the standardization of specifications for wood preservatives and the application thereof and to promote the use of treated wood.'

Membership

The list of members has grown from 160 in 1949 to 420 (including approximately 100 overseas members) in June 1960. Members include Learned Societies and Institutions concerned with forestry and estate interests, users of timber, producers of creosote and other perservatives, commercial pressure treaters of timbers, manufacturers of fire retardants and others.

Publicity and Education

A record of each annual convention is published, and the standard of the papers, which cover scientific interests and practical problems, have been of a high standard over the past 10 years with the result that the Convention Record is now accepted throughout the world as a valuable contribution to accumulated knowledge on wood preservation.

The Association possesses an extensive library of books, leaflets, pamphlets, wall charts and lantern slides which can be borrowed by members and which are loaned to and widely used in schools, colleges, member firms, certain government departments and kindred bodies for exhibition purposes.

During the past 10 years executives of the Association and members of the lecture panel have given over 500 lectures on timber preservation including at least 6 each year for the Ministry of Works. The Association has also provided lecturers for special courses on timber preservation organised by universities technical schools and the T.D.A.

Countless numbers of government departments, municipal authorities, architects, surveyors, engineers, estate agents, builders and property owners from home and overseas have taken advantage of the Associations' free advisory service.

Over the past 10 years over 500 articles on various aspects of wood preservation have been contributed to the local and national press and to scientific and trade journals. The aforementioned and other forms of publicity such as broadcasts and brains trusts have resulted in increased interest in the work of the Association.

Specifications

A most important part of the Association's work is the drawing up of specifications for timber preservation which not only cover the composition of the product used but also methods of application and methods of analysis so that gross absorptions and net retentions required for specific end uses can be attained.

Various specifications such as B.W.P.A. Standard 100. Specification for 'Celcure' Wood Preservative, have been approved, others are in their final stages and others are being prepared. These specifications also take into consideration service records which are carefully examined by the Specifications Committee before the specifications are approved.

Technical Committee

This committee has undertaken a considerable amount of work in the past decade, some of which has included the careful examination of documents prepared by other committees such as the Specifications and Service Records and Service Tests Committees. Examples of this work include:

(a) The preparation of a comprehensive document for the War Office on the treatment of timber for vehicle bodies.

(b) Report on preservative treatments for timber in buildings for the New Zealand Government.

(c) Liazon with the T.D.A. in connection with tests carried out for the eradication of sirex wood wasp in packaging timbers.

(d) Preparation of a new British standard on preservative treated plywood, to be dealt with by B.S. Technical Committee TIB/7/4.

Service Records and Service Tests

The Service Records and Service Tests Committee, which consists entirely of members with no commercial interests serves to test, for members of the Association, the long term efficacy of various types of preservation at various application rates of preservative, under varying conditions. Present tests include:—

(i) Marine borer tests at Poole Harbour where the main hazard is Gribble (*Limnoria*) although there is some evidence of *Toredo* attack. Elm fendering treated with a wide range of preservatives by different methods have been under test for 6 years together with control pieces of untreated elm. Annual inspection is carried out every September.

Similar marine borer tests were instigated in 1958 in Yarmouth Harbour and further tests are being carried out in slightly different manner at Shoreham.

(ii) In 1957, forty-two ladder sides of Douglas fir treated with a variety of preservatives were made into ladders and installed in the Tywarnhole Mine, Porthtowan, where exceptionally damp conditions lead to considerable trouble from various forms of decay. An annual inspection takes place each April.

(iii) Fencing posts of Scotch pine and birch treated with various types of preservative, have been undergoing trials at the Sunninghill Field Station of the Imperial College of Technology since 1958.

In conclusion it must be realised that the above represent only one or two of the Association's activities.

INTERFACIAL PHENOMENA in PESTICIDE APPLICATION

Introduction

MANY of the present chemicals used for crop protection are applied in liquid form. However, with a few exceptions most pesticides are not water soluble and, therefore, dispersions in the form of emulsions and suspensions have to be used. Some people, or rather regions, prefer emulsions, mainly because their relatively good stability enables homogenous application even in cases where stirring equipment in the spray tank is absent. Others prefer wettable powders because of their greater safety (excepting some herbicides) so far as phytotoxic hazards are concerned. Economy and other items are also taken into consideration.

In either case the ultimate goal is to spray the dispersed pesticide on to the target and good depositing is important from an economical standpoint. Although this is closely connected with spraying equipment and application techniques a number of physico-chemical features of the spray are also involved. General ideas on such factors cannot be given because present pesticides differ widely with respect to their mode of action and physical properties. This means that a given pesticide has to be formulated according to its mode of action and physical properties in order to obtain the greatest profit from its use. Much experience and skill is necessary to meet these requirements and in nearly all cases interfacial features are involved both from a physico-chemical and biological viewpoint.

In the last few years there has been a considerable demand for preparations, forming very stable dispersions, for application at high concentrations. These so called low volume spraying techniques have undoubtedly stimulated the development of better grinding apparatus that can mill solid pesticides down to ranges in the order of a few microns. Such finely ground preparations have given rise to rather unexpected problems, such as the tendency of the individual particles to aggregate the flocculate when they are dispersed in water. These difficulties may sometimes successfully be solved by using certain surfactants or dispersants, which accumulate at the surface of the dispersed particles and counteract aggregation. It is not the purpose of this paper to go deeply into such complicated interfacial phenomena. Moreover, little is known of the fundamental mechanism involved in such complex pesticidal preparations.

Ideas on interfacial phenomena will be given of emulsions (liquid/liquid interface) and suspensions (solid/liquid interface) of some pesticides.

The question of incompatibility of mixtures of pesticides will be raised in connection with physical properties of each individual component. The incompatibility from the chemical and biological viewpoint will not be considered.

Emulsions

The greater majority of present pesticides, which are applied as oil in water emulsions are formed by stirring the so-called "emulsifiable oils" into water. This step already presents a phenomenon, occurring at a liquid/liquid boundary and it is an example of the adsorption of a surfactant (emulsifier) at the oil/water interface of the system.

The presence of a "surface film" of the surfactant orientated at the dispersed oil globules stabilizes the emulsion; the ease by which the oil more or less spontaneously emulsifies when mixed with water, is due to the reduced interfacial tension brought about by the presence of the emulsifier in the oil.

The better the emulsifier is "balanced", viz. is able to be orientated at the oil/water interface, the tighter it clings to the dispersed oil droplets and the more stable is

the emulsion. The efficiency of our present emulsifiers can undoubtedly be ascribed to their correctly balanced structures as a result of which only a small quantity, e.g. 2—5 per cent. of these emulsifiers, suffices to emulsify the oil phase, viz. solutions of pesticides in hydrocarbons.

The interfacial tension of the oil phase towards the water phase in emulsifiable oils seems to depend mainly on the solvent used, for the pesticide dissolved in it has apparently no great influence on the oil/water interface, and consequently the emulsion performance. This may account, to some extent for the versatility (in that a great variety of pesticides can be formulated using only "one" surfactant for the preparation of the emulsifiable oil) of current emulsifier blends.

This statement is restricted to such pesticides, that are not, or only to a very low degree, water soluble and, therefore have no tendency to diffuse and accumulate at the boundary of the dispersed oil phase. If, however, the pesticide is somewhat water soluble, the orientated surfactant molecules at the oil phase of the emulsion may be disturbed by pesticide molecules slowly diffusing from the oil to the water phase. This in turn may lead to decreased emulsion stability and even breakdown. In such cases the emulsifier blend must be changed considerably for satisfactory results to be attained.

It is our experience that checking emulsifiers and thus the formula always pays, especially when large quantities of some emulsifiable concentrate have to be produced according to extreme stability requirements. In this case the blending of emulsifiers by experienced formulators will give all the security of quality and stability of the product required and in addition may result in the use of a smaller quantity of emulsifiers and hence a saving in costs. This intimate blending of emulsifiers is especially necessary if the pesticide contains some water soluble impurities inherent to the manufacturing process or due to slight decomposition on storage. Such impurities are sometimes difficult to characterise chemically and the amount may differ from batch to batch. They may, however, appear indirectly when emulsion characteristics of the pesticide in question are studied.

Our present emulsifiers are mostly blends of nonionic polyglycolethers and anionic dodecylbenzene—or petroleum sulfonates. They have made the application of emulsifiable oils more economical because of the low percentages necessary for good emulsion performance. This is in contrast to "old timers" such as Turkey red oil, Mahogany soaps, etc., which had to be used at percentages 4 to 5 times as high. Moreover, the modern emulsifiers have an additional advantage in that the depositing of the active oil phase onto the target surface is much higher. The reason for this lies mainly in the fact that the old emulsifiers were not balanced and indeed quite hydrophilic so that they had to be used at relatively high concentrations to perform satisfactorily. In fact they mostly formed colloidally dispersed emulsions, with characteristic low surface tensions. Depositing of such emulsions was recognised to be of a low order and excessive "run off" gave additional losses, which, in certain cases, made such protectants as DDT fail completely.

Nowadays, pesticides characterized by persistent activity are often favoured and it is understandable, therefore, that the formulator aims at producing those features—namely relatively coarse and quick breaking emulsions—that are necessary for good deposition. Yet it is astonishing that frequently, extremely heavy requirements and specifications, in respect of emulsion stability, are demanded, especially in tenders, This approach appears to be way behind the times when pesticides with a long residual action are involved.

Although one may expect, in such cases, that the preparation is meant to be applied in apparatus without stirring equipment and relatively good stability is wanted, the biological consequences, considered from the viewpoint of percentage deposition are obviously completely disregarded. The goal must be that the emulsion, formed by mixing the emulsifiable oil with water, is stable enough to ensure homogeneous application without risks for absorption or adsorption of the active oil phase to any part of the spray equipment till the time the tank is empty, whether the emulsion is stirred or not. The speed of breaking of the emulsion at the time of application is, of course, a further important point because it influences the percentage of active pesticide deposited on the target.

Obviously the phenomenon of emulsion breakdown in relation to time is closely connected with the particle size of the dispersed oil phase, the speed of emulsion droplets on their travel to the target, their mass and surface tension, the relative humidity and the temperature as well as the oil/waterphase ratio in the spray liquid. The surface properties of the leaves to be covered with the chemical are of course involved as well, especially when differences in structure and hydrophobic properties are considered.

It goes without saying that all these items cannot easily be taken into consideration when some emulsifiable oil is evaluated or tested. One would, however be inclined to evaluate the preparation as much as possible according to practical conditions. It must be considered that the state of division in an emulsion is very temporary and has nothing to do with the surface area formed thereafter when the emulsion has broken down on the leaf surface. One must remember, that during the evaporation of the continuous waterphase of a true oil/water emulsion, the dispersed oil droplets aggregate and form larger droplets until "free oil" is released, forming a more or less continuous oily layer on the substratum. This, of

course, is very dependent on the "oil" used as solvent for the pesticide (volatility, surface tension, percentage deposited, etc.). Much has been published on testing emulsion stability but as far as the author knows, all these procedures are based on stationary conditions. Yet it seems justifiable to consider as well the stability of emulsions when shaken under various conditions, similar to those generally present in practice. We have found that under those conditions the results with respect to stability are completely different from those found by other methods. Most emulsions, prepared of emulsifiable oils gain in stability when shaken, whereas emulsions made by diluting the concentrated so-called stock-emulsions, quickly breakdown. One could explain the stabilizing features in shaking tests of the former on account of orientation of the (balanced) emulsifiers at the oil/water interface in which case the shaking may favour the state of equilibrium.

Generally, no problems will be encountered when pesticides are formulated as an emulsifiable oil, provided that the pesticide is soluble in the commonly used solvents. Sometimes the aromatic petroleum distillates fail to dissolve the solid pesticide and relatively expensive solvents are used. As far as water immiscible solvents are concerned, this choice is understandable when the emulsion is intended to exert specific properties such as deposition and penetration. However, with water miscible solvents (even "miscible" to a low degree) it may be observed that the emulsion formed is soon transformed into a suspension in which the pesticide is in the solid state and crystallization is spontaneous. In such cases one might wonder if this type of formulation is justifiable because the wettable powder form of the particular pesticide may give an equally good performance and would in any case be much more economical.

However, general considerations on such matters may be erroneous because the surface layers of surfactants covering the crystals of the pesticide may exert additional biological effects, and in the case of herbicides may enhance retention, absorption and translocation.

Water dispersible powders

In the field of wettable powders (water dispersable powders) a great many problems may arise, which are much more difficult to solve in comparison to those presented to the formulator by emulsifiable concentrates.

These problems mostly involve flocculation and little is known of the fundamental features of the mechanism leading to such complicated interfacial phenomena.

The complexity of wettable powder formualtions makes fundamental studies with respect to flocculation unattractive, because such studies may be of doubtful value and more or less restricted to the components present in the composition. Considering the fact that these components may vary and that even slight variations as to their chemical composition, particle size, particle structure and interfacial tension may alter interfacial features, one understands the unattractive nature of the task facing the investigator. Although theoretical and fundamental knowledge on such physical aspects may be useful to arrive at a better approach for the solution of the various problems it can be seen why trial and error methods have apparently been more efficient in practice.

As in the case of emulsions, which are stablized by surface layers of surfactants adsorbed at the dispersed liquid phase, the solid particles of a suspension have to be stabilized to maintain the state of individual particles, that is complete dispersion. Depending on polarity, hydrophilic-hydrophobic properties (water-wax partition coefficient) surface charges and many other physical and chemical properties, finely divided solids may form dispersions in water of high, doubtful or low stability, inherent to their actual surface structure. Most organic pesticides are more or less hydrophobic and without surfactants lowering the surface tension of water and substantially the interfacial tension between the solid and water, no wetting would occur.

Most inert "carriers" or "diluents" used in wettable powder formualtions are hydrophilic and need no wetting agents to disperse them in water. Apart from the necessity to wet and to distribute all the solid particles homogeneously in water, the dispersion should be stable for some time to ensure homogeneous application during spraying. This cannot, in general be expected unless all the dispersed particles contain such surfactants, adsorbed at their surface, that are able to counteract any tendency of the particles to aggregate and subsequently flocculate. It may be expected, that the smaller the particles are, the more conditions favourable for closer contact (more particles) and, therefore, aggregation, are created. It is clear also that concentrated suspensions, (e.g. "low volume application") are subject to such flocculation unless special precautions are taken whilst making up the formulation.

The chemicals used for stablizing suspensions are adequately called dispersants and their activity to keep the particles individually dispersed is undoubtedly a mechanism of adsorption. The progress made in application techniques has greatly favoured low volume and especially aerial spraying and has thus forced wettable powder preparations to a very high degree of fineness and suspension stability. That the production of low particle size has been able to keep pace with the demand can be attributed, in some degree, to present grinding techniques with high speed running Pin Disk mills, Fluid Energy mills and very efficient airstream particle size classifiers.

However, low particle sizes result in the presence of high surface areas in relatively small amounts of spray liquid, and consequently associated stability problems. Unfortunately progress, with respect to stabilizing

concentrated suspensions consisting of solid particles having a mean particle size of <10 and even <5 microns against a flocculation, has not been so great as in the field of particle size reduction. This may be due to the complexity of the problem viz. finding or rather synthesizing dispersants which are selectively adsorbed at a more or less hydrophobic solid interface. The adsorption must occur via a water phase, in which the wettable powder is dispersed. It is understandable that such a dispersant must be, to some extent, soluble in order to be accumulated by means of a diffusion process at the interface of the particles to be stabilized against aggregation.

The presence of an inert carrier of distinct hydrophilic character may lead to strong competition for the sites of adsorption and relatively high percentages of the dispersant must be used to make it sufficiently available to the dispersed hydrophobic pesticide. In practice, however, as far as today's available dispersants are concerned, these percentages can be so high that there may be difficulties in the grinding process, doubtful economy and—where pesticides are used as a protective measure—detrimental effects on the rain resistance.

Although not originally meant as deflocculants, carriers having an extremely low particle size may in many cases prevent dispersions from flocculating. Synthetic silicic dioxide, a very fluffy and rather sorptive carrier, exerting a huge surface area, is especially useful in this respect. One could possibly explain this unexpected effect due to "buffering phenomena" as a result of reducing direct contact between the particles tending to aggregate and also by adsorbed surface layers of hydrated SiO_2. Whatever the mechanism may be, with such synthetic carriers it has been possible to manufacture highly concentrated wettable powders of DDT, BHC, etc (eg. 75% and higher) without pronounced flocculation when tested according to the rather heavy W.H.O. requirements. The principal purpose for using synthetic SiO_2 and Calciumsilicate has been their anti-caking properties in concentrated powdered preparations. In addition they are helpful in grinding "sticky" chemicals and thus they have made an excellent contribution towards the more economical production of highly concentrated pesticides.

From the viewpoint of biological performance however one could expect masking effects, with such contact-pesticides possessing very low water solubility and vapour pressure. This will depend, of course, on the percentage of "conditioning carriers" in the formulation and on the grinding technique, as well as on the degree of pesticide sorption on the carrier when the latter is dispersed in the water.

In the case of some herbicides, or more generally speaking of systemic pesticides, which should be absorbed and subsequently transported to exert their full potency, such features as particle size and sorptivity of the so-called "inert" carriers must be considered for the availability of the pesticide may decrease to such an extent that the biological performance may become rather critical.

The same statement may hold true for some acaricides which are characterized by an ovicidal and larvicidal activity. The striking effects obtained with Tedion (2, 4, 5, 4′ Tetrachlorodiphenylsufone), wettable powder, formulated with a sorptive and with a non-sorptive carrier have already been published.*

From the standpoint of biological performance, therefore, very special carriers excelling in low particle size and sorptivity cannot always be used in formulations, where they would perform excellently from a physical viewpoint.

The need for better dispersants is still with us and perhaps this need will be greater in the future when it is expected that more efficient chemcial control of pests will be attained by the use of more specific pesticides. Until better dispersants become available we must devise means of obtaining the highest possible performance from those in current use. For example mixing the wettable powder with very little water to form a smooth paste may force the dispersants to become adsorbed at the particles to be stabilised. Thereafter the paste may be further diluted and in many cases without the occurrence of flocculation or at least its retardation.

The stability depends very much on the water used (temperature, hardness, pH) and the procedure of the test, e.g. shaking the suspension or leaving it undisturbed during the time prescribed. These factors may disturb the state of interfacial equilibrium and flocculation may be observed as a result of a desorption phenomenon. This statement implies that such features should also be given attention when suspension stability tests of wettable powders are carried out for suspensions are nearly always stirred or shaken during application.

Physico-chemical phenomena of pesticides mixture

From the standpoint of the applicator, a number of pesticides must be sprayable when combined in the spray tank. The mixed spraying of pesticides for the purpose of controlling various pests by one application is understandable from economical considerations.

In many cases the biological results have not been in accordance to what might have been expected from the separate application of each individual pesticide. Moreover secondary effects have caused unexpected damage and combined spraying is increasingly considered to be rather doubtful and even dangerous. If, however, a combined spray mixture must be used, the combination should be based on the same type of preparation, viz. emulsions with emulsions and suspensions with suspensions.

(*a*) *Mixed emulsions*

The combined spraying of two or more emulsions generally does not lead to interfacial desorption phenomena so long as the surface charges of the emulsions carry the same sign. As in most cases, the emulsifier blends used are anionic and thus negatively charged, no problems will arise in general.

As stated, the well balanced present emulsifiers used for the formulation of emulsifiable oils, are so well sorbed at the oil/water interface that desorption is very unlikely to occur when a second oil/water emulsion, carrying the same principle at the interface is added.

Although no physico-chemical incompatibility is expected, the biological performance may alter and thus one must clearly interpret the conception of compatibility.

(*b*) *Mixed emulsions and suspensions*

It is not possible to describe briefly and more or less generally the very complicated phenomena that occur when a suspension is added to an emulsion and vice-versa. In general, however, one may observe that both the emulsion and the suspension breakdown completely, sometimes forming a sludge sticking to the spray apparatus. Apparently, the introduction of new, completely different interfaces into the emulsion or into the suspension disturbs the state of equilibrium present prior to the mixing and leads to desorption phenomena and possibly to further adsorption of the surfactant(s) at the other interface.

(*c*) *Mixed suspensions*

When two or more pesticides, formulated as wettable powders are mixed in the spray tank, complications may occur. A few suggestions will be given as to the possible causes of the interfacial phenomena, in relation to the shortcomings of our present dispersants. The best dispersants of the present day belong to the sulfonates, a group in which the lignosulfonates excel both from the efficiency and economical viewpoints Calcium and Soidum lignosulphonates are marketed either as they are or in partly desulphonated or completely desugared forms, each having different properties regarding water solubility, pH, dissociation and therefore sorptivity onto solid interfaces, all of which cause them to differ significantly as to their relative dispersing activity.

The surface structure and the surface properties of the interfaces which are present in wettable powder dispersions signficantly determine the sorption phenomenon. This involves a rather complicated and sensitive system because it is governed by many factors when the state of equilibrium is reached. It is understandable that the weaker the forces holding the dispersant at the interface, the less stable the dispersion will be. According to the statement that our present dispersants are not ideal from the viewpoint of balance and the fact that other features, influencing the degree of sorbitivity, are also involved in practice, it can be seen that the situation is not very attractive.

Thus, when a wettable powder suspension is mixed with another one, the equilibrium present in both dispersions prior to mixing is very likely to be influenced. Obviously the introduction of a new interface shapes new and generally different conditions as to sorption, and therefore, stability.

Unless either wettable preparations is quite overdosed with dispersant, thus maintaining sufficient supply in the water phase, flocculation is commonly observed. Gentle stirring, however, may keep the combined preparations well dispersed to ensure homogeneous spraying, provided of course, that all the surfactants used in the preparations are of the anionic or nonionic type. Cationic surfactants are used but little for pesticide formualtions and this is one of the bright spots in this complex situation. Obviously applicators will find the problem occurring when wettable powders are mixed together, to be of little importance provided that his spray equipment is fitted with an automatic stirrer. Stirring, however, may, in some cases, enhance flocculation and lead further to breakdown of the suspensions. This may occur for example in the case of wettable powders containing liquid pesticides (parathion, malathion, ethion), which are sorbed by certain silicates (Attapulgites, Calcium silicate) or silicic dioxide (kieselguhr) and thus appear in dry state.

When such wettable powders are suspended in water, part of the liquid pesticide is released from the adsorbant and absorbant carrier. In other words, the dispersion contains a liquid phase in the state of a rather coarse and unstable emulsion as well as a solid phase, containing the liquid pesticide in a more or less absorbed state. It is quite understandable that such a complicated dispersion is already sensitive with respect to the interfacial equilibrium. When such dispersions are mixed with a fungicide, e.g. Thiram wettable powder, both dispersions may breakdown completely. The fact that the aforementioned phosphorous compounds may act as solvents for other pesticides, makes the biological performances at least doubtful.

The combination parathion or malathion with dithiocarbamate fungicides, however, is often required and from the viewpoint of fungicidal activity it is essential to maintain the fungicide particles in a high state of division, for obviously any change in the state of division will alter the level of fungicide available for control purposes. The fact that both the physico-chemical and biological compatibility of the above combination may be adjusted by proper formulation demonstrates the progress one can make when the practical problem is clearly presented.

*—*Mededelingen Van de Landbouwhogenschool te Gent* 1958 *Peel XXIII No.* 3–4.
Results show that the initial activity of Tedion formulated with a non-sorptive carrier is 3 *times greater than when a sorptive carrier is used.*

NEWS

Control of Flies Sought by Chemical Sterilization to Prevent Reproduction

Self-annihilation of insects by chemical sterilization, which prevents reproduction, is being tried in experiments by scientists of the United States Department of Agriculture as a means of controlling house flies and fruit flies.

These experiments mark the first laboratory trials of one of three new methods of insect control or eradication by self-destruction proposed recently by Dr. Edward F. Knipling, head of entomological research for the Department of Agriculture's Research Service. They will provide basic information on possibilities of applying the principle of induced sterility by means of chemicals.

The compound being experimentally used to sterilize the flies is a modified glutamic acid. Trials have shown that a concentration of as little as 1/100th of one per cent of this chemical added to food for laboratory-reared house flies has prevented egg-laying or hatching and that 0.5 of one per cent in a single feeding will cause permanent sterility in female flies. Although satisfactory for use in testing the principle of chemical sterilization, the modified acid may not prove completely suitable as a practical means of insect control by this method. The experiments are being conducted at the U.S. Department of Agriculture's entomology laboratory at Orlando in Florida, by Drs. Germain C. Labrecque and Carroll N. Smith, and Patrick H. Adcock.

In one laboratory experiment, equal numbers of fly pupae were placed in three separate rooms—one containing food treated with the chemical, the second containing equal amounts of treated and untreated food, and the third containing untreated food only. Although more than 20,000 progency were produced in the room in which untreated food was available, only 100 or 0.5 of one per cent were produced in the room in which treated food was offered, and 460 or about two per cent, in the room in which both treated and untreated food was supplied.

In another experiment treated food was given to female flies for a single day. The flies produced viable eggs the following day but only a single fly produced viable eggs thereafter.

Male flies, according to tests made so far, are not sterilized by eating food containing the chemical. To be fully effective, chemical sexual sterilants of maximum effectiveness will have to produce sexual sterility in both males and females without adverse effects on mating behaviour.

Control of house flies through release of male flies sterilized by irradiation has been considered. This method has been used successfully on screw worms in the south eastern States and on the Caribbean island of Curacao. Dense populations of house flies, however, and the need to release equal or greater numbers of sterilized flies to overcome wild populations, are limiting factors in the use of this method to control this pest.

The chemical sterility method now under study, if eventually successful, would not require release of treated flies, as food treated with an effective chemo-sterilant could be made generally available.

Other control and eradication methods recently suggested by Dr. Knipling include the production and release: (1) of diseased insects to infect and kill their own kind, and (2) of insects possessing lethal genetic characteristics that could control or eradicate an insect pest. The first of these two methods is also being investigated by the USDA under laboratory conditions, but investigations on lethal genetic characteristics are not yet underway.

Medical Experts Pass Pesticides

At the beginning of this year Gaylord Nelson, Governor of Wisconsin, U.S.A. gathered a committee of health and nutrition experts to study the health hazards arising from the use of chemical food and feed additives, etc., and to develop a decisive and consistent policy in respect to regulating the use of chemicals as feed supplements, food additives, pesticides and growth regulators, (*see Pest Technology* **2** (7), 151).

The report of this committee has recently been published and states in conclusion that "At the present time there is no scientific basis for serious alarm over the safety and quality of foods available to the American people."

Whilst realising that painstaking research, conscientious inspections, testing and vigilant enforcement of necessary regulations continue to be essential government responsibilities and that anticipated increases in the use of chemicals will require further increases in inspection, testing, educational and enforcement programmes, the committee emphasized that the dangers of inducing cancer or other toxic effects through consumption of any of the treated foods now generally available are certainly minimal.

It appears that, in America, great apprehension is frequently aroused through the publication of statements that certain of the chemicals used are capable of producing cancer. In answer to these fears the committee urged people to be more reasonable in this matter for such statements that arouse apprehension are often misleading as they do not explain the conditions under which the substances will produce the claimed effects. The statements fail to take into account that many chemicals, which may be hazardous in large quantities and under conditions of unusually long exposure, are harmless under conditions which would be encountered in ordinary circumstances. For example a solution of common table salt, in greater quantities than found in the body fluids, is known to be capable of producing cancer in rats when injected sub-cutaneously.

Referring to pesticides the report stated that it is generally recognised that they will continue to be used to an ever increasing extent, without them total agricultural production in America would decline seriously. All chemical agents now approved for use in America have been thoroughly tested for toxic properties and approved methods for use are required on all commercial labels. *In all reported instances where health hazards have been created, the ultimate cause was failure to comply with recommended methods for use.* Expansion and intensification of educational programmes should be undertaken to warn both food producers and the public that only through proper use can pesticidal substances be safely used.

I.P.C.A. Film Library

Through the courtesy of members the Association has compiled a list of films which are available on loan for showing to interested organisations such as Women's Institutes, Women's Guilds, Young Farmers' Clubs, meetings of Local Government Officers. The films depict some aspects of the use of insecticides and rodenticides for control of pests causing disease, damaging timber and foodstuffs in store.

Requests to borrow the films should be made to:-
Industrial Pest Control Association,
Cecil Chambers,
86 Strand,
London, W.C.2.

"INSECTS ASTRAY"
16mm. Black and white; sound
35 *minutes*

Historical survey of moth proofing from prehistoric to present times.

The Geigy Company Ltd.

"MALARIA"
16mm. only. Sound, black and White
15 *minutes*

This film explains the way in which the malaria parasite attacks the human bloodstream; it also examines the two groups of mosquitoes—the anophelines and culicines—and considers means of protection against malaria.

Shell Chemical Company Limited.

"NO TROUBLE IN STORE"
16*mm. Sound and colour*

Describes how, by methods of hygiene and the use of insecticides, food wastage can be avoided.

Cooper, McDougall & Robertson Ltd.

"SARDINIAN PROJECT"
35*mm. and* 16*mm. Sound*
Black and White 36 *minutes.*

Is concerned with the effect of malaria on the inhabitants of Sardinia and reports on the campaign undertaken to eradicate anopheline mosquitoes from the island.

Shell Chemical Company Limited.

"THE CHALLENGE"
16*mm. Sound and colour*
18 *minutes.*

This film illustrates the history of the rat from early times and shows how it has been closely associated with man in various environments throughout the world.

Attention is drawn to the role of the rat in the spread of disease, and in the cause of damage to buildings and foodstuffs. It is emphasised that the control of rodents calls for specialised knowledge and training in the use of modern rodenticides and rat-proofing techniques.

Disinfestation Limited.

"THE RIVAL WORLD"
35*mm. and* 16*mm. Sound*
Colour, 26 *minutes.*

The challenge of the rival world of insects which outnumber man by fifty millions to one. The ever-present battle to preserve the world's food supplies from the depredations of insects, their grim effect on health and some of the measures taken to combat the havoc they cause.

Note.—As insects in close-up can be fearsome and the diseases shown unpleasant, this film is perhaps unsuitable for showing to young children.

Shell Chemical Company Limited.

"THE RUTHLESS ONE"
35*mm. and* 16*mm. Sound*
Colour, 18 *minutes*

Portrays the life-cycle and behaviour of the desert locust, and indicates the magnitude and nature of the locust problem, the need for international co-operation to deal with it, and something of the work undertaken by the Locust Research Centre in London.

Note.—The recommendation in the footnote to 'The Rival World' also applies, particularly in view of a mating sequence.

Shell Chemical Company Limited.

"THE PYRETHRUM STORY"
16*mm. Colour and sound.*

Tells how the Pyrethrum flower is grown in Kenya and other equatorial countries and how it is harvested and processed to produce a highly effective insecticide.

The African Pyrethrum
Technical Information Centre.

"THE STORY OF D.D.T."
16*mm. Black and white;*
Sound, 23 *minutes.*

Historical account of discovery and development of D.D.T.

The Geigy Company Limited.

"UNSEEN ENEMIES"
16*mm. and* 35*mm. Sound,*
Colour, 32 *minutes.*

This film illustrates the effects of infectious diseases such as leprosy, yaws, malaria and many others. It shows that the effects can be cured or alleviated by medical means or their transmission halted by destroying the vectors with systematic application of insecticides. It also shows that an attack must be made on the living conditions in which diseases flourish, namely dirt, over-crowding, polluted air and water.

Basically the aim of the film is to show the need for social planning to support the medical progress.

Shell Chemical Company Limited.

"VENEZUELA FIGHTS MALARIA"
35*mm. and* 16*mm. Sound,*
Black and white, 21 *minutes.*

While this film also contains sequences indicating the ravages of the malaria parasite on the human bloodstream, the greater part of the film is concerned with the particular antimalarial efforts made in Venezuela.

Shell Chemical Company Limited.

"EVERYMAN'S ENEMY—THE HOUSEFLY"
16*mm. colour film:* 20 *minutes*

The life history and habits of the housefly are described. The reasons why it cannot be tolerated in hospitals, factories, etc., are given and the possibility of flies acting as disease carriers is mentioned. Control in relation to the collection and disposal of refuse by local authorities is described and there are some shots of a power sprayer and a hand operated knapsack sprayer in action on a refuse tip. Electrically driven Mist Generators are shown in use in a factory and Aerosol Flysprays in a hospital and shop. Some methods for testing insecticides are briefly described.

Cooper, McDougal & Robertson Ltd., (U.K. Division)

"HOUSE FOR SALE"

16*mm. sound and colour*
22 *minutes*

This film tells the story of a young married couple in their search for a cottage in the country and the frequency with which such buildings are attacked by Woodworm. The life cycle of the Common Furniture Beetle is depicted and this sequence includes shots of a larva burrowing into the wood and the adult emerging through a flight hole.

Disinfestation Limited

New Aquatic Weedkiller

Borax Consolidated Ltd., have announced a new addition to their range of general weedkillers. It is an aquatic herbicide based on dalapon and is recommended for the control of rushes, reeds, sedges and similar species.

The product is available in 56 lb. drums at prices from 8/- per lb. or in 14 lb. drums at prices from 9/- per lb. With application rates varying from 15—30 lbs. per acre it is thought that drainage authorities could economically replace laborious hand cutting and clearing by the use of this technique.

Large Pakistan Order for Micron

Micron Sprayers Ltd., of 44 Bradford Street, Birmingham 5, a member of the Birfield Group of Companies, has received an order from the Pakistan Government worth £37,500 for their concentrate spraying machine.

Included in the order are five hundred shoulder-mounted Micronettes, ten Micron Megs and nine sets of Micronair equipment. All the machines will incorporate Micron rotary atomisers which produce extremely fine, uniform spray droplets most suitable for concentrate spraying.

The Company state that the concentrate spraying of crops is now being widely accepted both in the United Kingdom and overseas, and more growers in all parts of the world are turning over to this system of spraying. Application rates of two to five gallons per acre are very much easier and quicker to apply than the rates of up to 300 gallons per acre required with high or medium volume sprayers, and with the modern Micron system for producing finer spray droplets the cover obtained is at least as good. Wastage from "drip-off" is also eliminated.

CORRECTION

Please note that the caption to the diagram on page 198 of the July issue—"*Concentration of Pentachlorophenol (lbs. per square foot)*" should read **"Concentration of Pentachlorophenol (lbs. per cubic foot)"**.

Institute of Wood Science

At a Meeting of the Qualifications and Examinations Sub-Committee of The Institute of Wood Science held on Monday 18th July, 1960, the following were elected Fellows:-

D. R. Carr, B.Sc., of Epsom who is well known for his original publications on Boron toxicities, and was for many years on the Staff of the New Zealand States Forest Service.

Professor F. Jane of London, who is so well known to members of the Institute not to require any further introduction.

R. A. G. Knight, B.Sc., of Princes Risborough. Officer in Charge of composite wood section of F.P.R.L.

Professor R. D. Preston, F.R.S. of Leeds University who is well known for his work with the electron microscope on the subject "Sub Microscopic Structure of Wood." Members will remember his recent lecture on this subject to the Institute.

E. A. S. Price, M.A. (Oxon.) of South Milford, whose research work on soft rots is known at home and overseas.

The following were granted Associatship:-

H. R. Brown,	Cranham
A. J. Browning,	Leeds
A. Gordon Foster	London
B. A. Richardson, B.Sc.	Winchester

Certified Members:

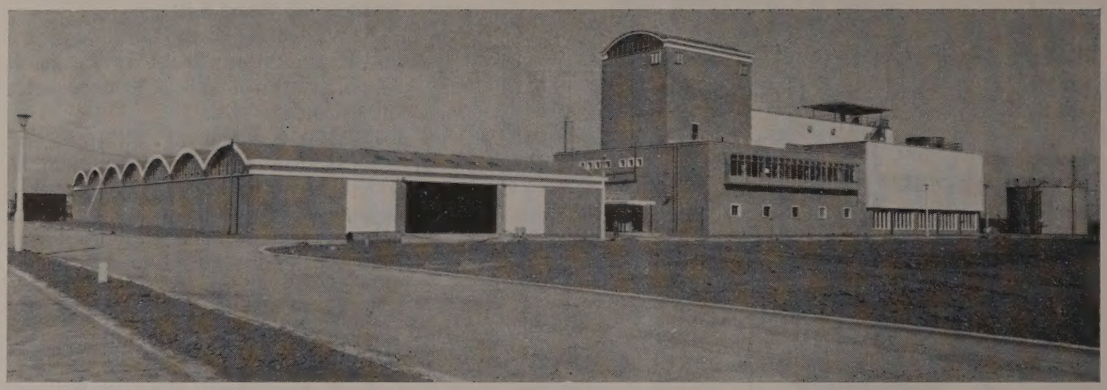
F. T. W. Austin,	Southampton
R. F. Baldwin,	Newent
H. J. Carter,	Bristol
B. M. Easton,	Wokingham
W. Goodbrand,	Glasgow
H. V. Gowers,	Aldenham
H. Hopper,	Rainham
S. T. Horning,	London
K. Jarvis,	Sheffield
R. Kelly,	Harrow
M. Leigh,	Bath
M. J. Levine,	Ilford
R. O. Martin,	Sunderland
R. R. Morris,	Andover
R. C. Palmer,	Billericay
A. C. Thomas,	Keynsham

Ordinary Members:

Miss J. P. Firth,	Leeds
J. C. Fox,	Mombasa
W. Hue-Smith,	Rowlands Castle
H. H. Knowlton,	Hayes
J. S. Perrin,	Kidderminster
L. Peverett,	Mombasa
R. T. Walker,	Stroud
P. G. Williams,	Ascot

Junior Members:

K. D. Elliott,	Bradford



Photo—

Dow Agrochemicals Limited

Dow's New £1 Million Chemical Factory

A remarkably fine example of modern chemical engineering in contemporary architecture, Dow Agrochemicals Limited's new £1,000,000 factory has just been completed on its 80-acre site on the Great Ouse Estuary at King's Lynn, Norfolk. It represents the first stage in what may ultimately become one of the largest agricultural chemical factories in Europe, and will produce Dowpon, the systemic selective killer of couch grass and other grass weeds and reeds, which has hitherto been imported. Equipment and instrumentation is of modern design and includes special corrosion-resistant materials such as stainless steel, nickel, glass and plastics. The plant has been completed two months ahead of schedule by Constructors John Brown Ltd., to the architectural design of Mr. E. Maxwell Fry, F.R.I.B.A. Other Dow products now imported, including Etrolene (the anti-warble fly drug) Zoamix (a coccidiostat) and Nankor, a new non-toxic fly killer of great persistence, will in the near future be manufactured here also. With the completion of the factory, Dow Agrochemicals announce steep reductions in the Dowpon price range.

New Spraying-Misting and Dusting Unit has Great Flexibility

A completely new spraying-misting and dusting unit possessing great flexibility and capable of delivering a mist-spray or dust from any angle or direction, has been developed by Microto Treating Ltd., Willow Road, Poyle Estate, Colnbrook, Bucks. (CN8/2587). It is claimed to be the most versatile unit at present available on World markets.

It comprises a sub and main chassis. The sub chassis is capable of direct mounting on to an existing chassis if required in which case the main chassis would not be needed. The power unit is a 4-stroke air cooled petrol engine developing 6h.p. at 3,500 r.p.m. This drives the main fan by direct coupling and the pump by single 'V' belt drive. Both the pump and engine are mounted direct to the sub chassis.

The air blast from the fan is split up by bifurcated trunking into flexible spraying arms from where it passes out through the four fingers of the dual adjustable hands. At this point, it atomises the spraying liquid which has been delivered to adjustable nozzles inside each of the four fingers through a flexible rubber hose from the delivery pump. The spray droplet size is between 60/120 microns, according to the position of the regulating valves on the pump delivery side. There are two valves so that either, or both spraying hands may be operated as required. There is also a by-pass valve to ensure that a quantity of liquid is pumped back into the supply tank, thus ensuring agitation of the liquid.

Spraying application can be done at a rate of 5 gallons to 180 gallons per acre, depending upon the material used, the type of crop and the season.

The Microto Treating machine can also be used for mosquito, tse-tse fly and locust control as well as crop work. In its complete form the Microto Treating unit would be fitted with a 45/65 gallon capacity tank and mounted on two pneumatic wheels fitted with 6″ × 16″ agricultural tyres and tubes.

The arms and hands are fully adjustable, and the trunking can be raised or lowered by means of a worm drive gear on the fan casing.

Dusting Unit

The Dusting Unit is a separate attachment which can be fitted to the fan outlet point in place of the spraying unit. Dust is fed into the air stream from an independent hopper fitted with a regulator, and passes out through a bifurcated trunking to two orifices. It does not at any point pass through the fan or fan casing. The dust can be applied dry or wet, according to requirements. As with the sprayer, the Duster is adjustable in every place and at all angles and has a range of more than 100 feet vertically in still air conditions.

Wood Pigeon Nest Destruction—M.A.F.F. Announcement

Wood pigeons are a serious menace to crops, particularly in East Anglia, and it is very much in the interests of farmers, land-owners and other occupiers of land to join the campaign which starts towards the end of this month to reduce the numbers of this pest. Grants for the destruction of wood pigeons' nests are made to rabbit clearance societies who carry out this work for their members. The essential features are that nest destruction should be done over the whole of the area and at specified periods.

An explanatory leaflet describing nest destruction may be obtained from any of the Ministry's divisional offices. Farmers should join a rabbit clearance society if there is one in their district; if there is not, they should, in their own interests, get together quickly to form a new society.